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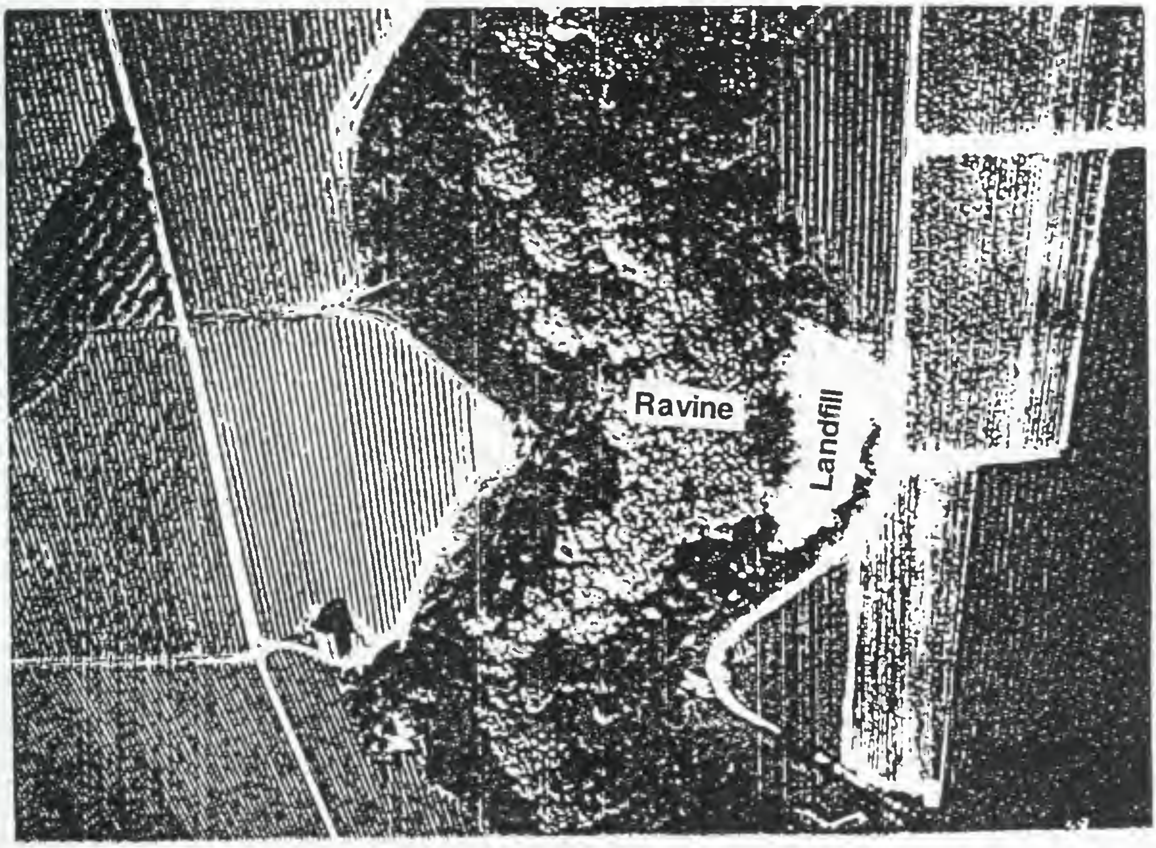
Report No: SDB-062-3511-96

Executive Summary

The soil data indicates that the Hemder landfill has not resulted in significant chemical contamination of the adjacent ravine to the west. Ravine soil concentrations of all test parameters, including the elevated PAH concentrations, were very low in relation to the MOEE effects-based soil criteria and would not adversely affect the ravine. Trees adjacent to the landfill's steep west slope have declined because of soil build-up over their roots, as a result of erosion of the landfill cap and soil sliding into the ravine.

Hemder Landfill Site and Adjacent Ravine Sampled to the West (1995)



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Phytotoxicology 1995 Soil Investigation: Hernder Landfill, Lincoln

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Introduction

On March 31 1995, the Ministry of Environment and Energy (MOEE) West-Central Region Welland District office requested that the Phytotoxicology Section conduct sampling in the treed ravine adjacent to the Hernder landfill in Lincoln. The sampling was requested because of recent public concern that the landfill may be adversely affecting the watercourse and trees in the ravine. In the spring of 1995, the MOEE received a complaint about the soil cover on the steep west slope of the landfill sliding into the ravine and damaging trees. Phytotoxicology staff (R. Emerson), assisted by Keith Anderson (MOEE, Welland), conducted soil sampling on October 11, 1995.

The wastes disposed at the landfill during its 40 years of operation included building rubble (wood etc.), pesticide containers, and hazardous materials such as used motor oil, oil containers, and lead batteries. The present owner (F. Hernder) recently closed the landfill and capped all working faces with surplus soil from the MTO QEW highway expansion project. Prior to closure, scheduled pesticide containers and hazardous materials were removed from the landfill.

Observations

The treed ravine was situated immediately west of the Hernder landfill and a small watercourse meandered along the ravine floor just west of the landfill's steep west slope. At approximately the horizontal mid-point of the base of the slope, the landfill cap had a wide gap exposing buried rubble/waste in the landfill. This was the only area where landfill waste was visible along the west slope. Gulleys extended down the steep slope. Mature ravine trees that were dead or declining at the bottom of the west slope had soil build-up around their trunks as a result of erosion of the landfill cap and soil slides down the slope into the ravine. Soil build-up over tree roots can deplete soil oxygen levels and cause root suffocation and tree death. All soil samples collected from the ravine floor had a normal earthy odour and were free of staining.

Sampling

To determine the status of the ravine soil in the vicinity of the affected trees and the neighbouring watercourse, soil samples were collected from two ravine sites just east of the watercourse within 10 meters west (downgrade) of the steep landfill slope. One site was situated just west of the deep crack in the landfill cap (where waste/rubble was visible) at about the horizontal mid-point of the slope base, while the other site was closer to the north end of the west slope of the landfill. In addition, a ravine control site was sampled upstream (south), away from the landfill. At each site, numerous soil cores to a 15 cm depth were collected and placed in a stainless steel bowl and mixed thoroughly. The soil was then placed in appropriate containers (e.i., polyethylene bags for inorganics, or amber jars with foil-lined lid for organics). The sampling was repeated to provide duplicate samples for analysis.

Prior to sampling, the sampling equipment was cleaned following the MOEE protocol for organic sampling. Latex gloves were worn during sampling as a further measure to prevent cross contamination.

Submission for Analysis

All soil samples were submitted to the Phytotoxicology Section processing laboratory. There, the jars of soil for organic analysis were refrigerated. The remaining soil samples were air dried, ground, and stored in glass bottles. They were then tested for pH and electrical conductivity (measure of total salts in soil) in the Phytotoxicology laboratory. All samples, including the refrigerated soils, were then submitted to the MOEE's Laboratory Services Branch for analysis of possible landfill contaminants. The soils were analyzed for 21 inorganic parameters (i.e. lead, cadmium, mercury etc.), and several organic parameters - solvents, pesticides, phenols, petroleum hydrocarbons, PAHs and PCB.

Analytical Results

The soil analysis results in Table 1 (inorganic) and Table 3 (organic) are compared to the control site and to the Ontario Typical Range (OTR) guidelines. Table 2 lists all the organic parameters for which the soil samples were analyzed. OTRs are background-based guidelines and represent typical soil concentrations in parks across Ontario (Appendix A). All results are compared to the rural park OTRs, with the exception of the PAH results. The PAH results are compared to the urban park OTRs because of the absence of validated rural park OTRs for PAHs. A soil concentration in excess of the OTR indicates the likely presence of a source of contamination. The tables also show the MOEE soil remediation quidelines which are applied when contaminated lands are being decommissioned and subsequently re-developed for residential, parkland or agricultural use. These criteria apply to soils at any depth and are effects-based numbers based on health of plants, animals and humans. The inorganic results are expressed as µg/g (micrograms/gram, also referred to as ppm or parts per million) and the organic results as ng/g (nanograms/gram, also referred to as ppb or parts per billion).

Table 1 shows that the two ravine sampling sites adjacent to the landfill have normal soil concentrations of metals and all other inorganic parameters relative to the control site and MOEE guidelines. Both sites also had normal pH (7.1-7.4) and electrical conductivity (0.23-0.25 millisiemens/cm) ranges.

Table 3 shows the organic compounds with detectable soil concentrations at one or more of the sampling sites. Concentrations of the organic compounds listed in Table 2, but not shown in Table 3, were below analytical detection limits. Soil PAH concentrations at the ravine site adjacent to the horizontal mid-point of the landfill base are elevated relative to control levels, which implicates the landfill as a possible source. However, as even the highest soil PAH levels were similar to OTR values and were well below the MOEE effects-based soil criteria, the soil PAH concentrations at this sampling site are not excessive and would not adversely affect the ravine. The ravine site at the north end of the landfill slope had soil PAH concentrations similar to the control site. The concentrations of organo-chlorine insecticides detected in the ravine also were similar to background levels. On the basis of the chemical results, the Hemder landfill would appear not to be a significant source of off-site contamination to the soil in the adjacent ravine.

Conclusion

The soil data indicates that the Hemder landfill has not resulted in significant chemical contamination of the adjacent ravine to the west. Ravine soil concentrations of all test parameters, including the elevated PAH concentrations, were very low in relation to the MOEE effects-based soil criteria and would not adversely affect the ravine. Trees adjacent to the landfill's steep west slope have declined because of soil build-up over their roots, as a result of erosion of the landfill cap and soil sliding into the ravine.

Table 1: Soil Concentrations* of Inorganic Parameters in the Ravine Adjacent to the West Slope of the Hernder Landfill (1995).

Parameter	Mid Slope West of Cap Crack	North End of West Slope	Control Site	MOEE Soil Guidelines	
				OTR	Remediation**
Aluminum	17,000	15,000	18,500	30,000	NG
Antimony	0.3 T	0.3 T	0.3 T	0.4	13
Arsenic	5	5	5	11	25
Barium	94	85	99	160	1,000
Beryllium	0.7 T	0.7 T	0.8 T	1.1	1.2
Cadmium	0.5 T	0.6 T	0.6 T	0.7	12
Calcium	20,000	22,000	24,500	55,000	NG
Chromium	24	22	26	58	1,000
Cobalt	12	12	13	16	50
Copper	29	27	30	41	300
Iron	24,500	23,000	26,500	35,000	NG
Lead	26	23	20	45	200
Magnesium	8,300	7,900	8,950	20,000	NG
Manganese	705	745	815	2,200	NG
Mercury	0.04 T	0.03 T	0.03 T	0.13	10
Molybdenum	DL	DL	DL	1	40
Nickel	26	23	26	38	200
Selenium	0.4 T	0.5 T	0.4 T	0.93	10
Strontium	49	51	58	64	NG
Vanadium	36	33	38	77	250
Zinc	81	76	94	120	800

*ug/g, dry weight, mean of duplicate samples and analysis. T - Trace amount, interpret with caution.
**MOEE soil criteria for remediation of lands intended for agricultural or parkland use. NG - No guideline.
OTR - Ontario Typical Range for rural parkland. DL - Concentration at or below analytical detection limit.

Table 2: Organic Compounds Analyzed in Soil Samples: Hernder Landfill (1995)

Chlorinated Solvents & Petroleum Hydrocarbons	Toluene	Pyrene	Heptachlor epoxide
	0-xylene	***Organo-Chlorine Pesticides & PCB***	Mirex
Benzene	m- and p-xylene		Methoxychlor
Bromodichloromethane	Petroleum distillates	Aldrin	Total PCB
Bromoform	***PAHS***	a-BHC (hexachlorocyclohexane)	***Chlorophenols***
Carbon tetrachloride	Acenaphthene	b-BHC (hexachlorocyclohexane)	Dicamba
Chlorobenzene	Acenaphthylene	g-BHC (hexachlorocyclohexane)	Pentachlorophenol
Chloroform	Anthracene	a-Chlordane	Picloram
Dibromochloromethane	Benzo (a) anthracene	g-Chlordane	2,4-D
1,2-dichlorobenzene	Benzo (b) fluoranthene	Oxychlordane	2,4-DB
1,3-dichlorobenzene	Benzo (k) fluoranthene	pp-DDD	2,4-D-propionic acid
1,4-dichlorobenzene	Benzo (a) pyrene	pp-DDE	Silvex
1,1 dichloroethane	Benzo (g,h,i) perylene	op-DDT	2,4,5-T
Trans-1, 2-dichloroethene	Chrysene	pp-DDT	2,3,4-trichlorophenol
Dichloromethane	Dibenzo (a,h) anthracene	Dieldrin	2,3,4,5-tetrachlorophenol
Ethylbenzene	Fluoranthene	Endosulphan 1	2,3,5, 6-tetrachlorophenol
Tetrachloroethene	Fluorene	Endosulphan 11	2,4,5-trichlorophenol
1,1,1-trichloroethane	Indeno (1,2,3-c,d) pyrene	Endosulphan sulphate	2,4,6-trichlorophenol
1,1,2-trichloroethane	Naphthalene	Endrin	
Trichloroethene	Phenanthrene	Heptachlor	

Table 3: Soil Concentrations* of Organic Compounds in the Ravine Adjacent to the West Slope of the Hernder Landfill (1995).

Parameter	Mid Slope West of Cap Crack	North End of West Slope	Control Site	MOEE Soil Guidelines	
				OTR	Remediation**
Polycyclic Aromatic Hydrocarbons (PAHs)					
Acenaphthene	40 T	20 W	20 W	32 T	15,000
Anthracene	80 T	20 W	20 W	58 T	28,000
Benzo(a)anthracene	140	40 T	40 T	360	6,600
Benzo(b)fluoranthene	140	20 W	40 T	300	12,000
Benzo(k)fluoranthene	80 T	20 W	20 W	260	12,000
Benzo(g,h,i)perylene	80 T	40 W	40 W	280 T	40,000
Benzo(a)pyrene	120 T	40 W	40 W	300	1,200
Chrysene	160	60 T	40 T	350	12,000
Fluoranthene	400	60 T	60 T	560	40,000
Fluorene	40 T	20 W	20 W	39 T	340,000
Indeno(1,2,3-c,d)pyrene	80 T	40 W	40 W	230 T	12,000
Naphthalene	60 T	20 W	20 W	75 T	4,600
Phenanthrene	340	60 T	40 T	310	40,000
Pyrene	280	40 T	60 T	490	1,300
Organo-Chlorine Insecticides					
pp-DDE	54	85	91	NG	1,600[1]
op-DDT	5 W	5 W	10 T	5.4	NG
pp-DDT	35 T	45 T	40 T	75	NG
Total DDT (op + pp)[R]	35 T	45 T	50 T	NG	1,600[1]

*ng/g (ppb), highest concentration detected in duplicate samples. **MOEE soil remediation criteria for residential/parkland use. W - Concentration at or below analytical detection limit. T- Trace amount, interpret with caution. [1]Criteria for Total DDE or Total DDT. [R] In calculating total DDT, W values for op-DDT were halved and added to corresponding pp-DDT values, and the sum rounded off to nearest whole number. OTR - Ontario Typical Range for old urban parkland, see Appendix A.

Appendix A

Derivation and Significance of the Ontario Ministry of Environment and Energy(MOEE) "Ontario Typical Range" of Chemical Parameters in Soil, Vegetation, Moss bags and Snow

The MOEE "Ontario Typical Range" (OTR) guidelines are being developed to assist in interpreting analytical data and evaluating source-related impacts on the terrestrial environment. The OTRs are used to determine if the level of a chemical parameter in soil, plants, moss bags, or snow is significantly greater than the normal background range. An exceedence of the OTR_{98} (*the OTR_{98} is the actual guideline number*) may indicate the presence of a potential point source of contamination.

The OTR_{98} represents the expected range of concentrations of chemical parameters in surface soil, plants, moss bags, and snow from areas in Ontario not subjected to the influence of known point sources of pollution. The OTR_{98} represents 97.5 percent of the data in the OTR distribution. This is equivalent to the mean plus two standard deviations, which is similar to the previous MOEE "Upper Limit of Normal" (ULN) guidelines. In other words, 98 out of every 100 background samples should be lower than the OTR_{98}.

The OTR_{98} may vary between land use categories even in the absence of a point source of pollution because of natural variation and the amount and type of human activity, both past and present. Therefore, OTRs are being developed for several land use categories. The three main land use categories are Rural, New Urban, and Old Urban. Urban is defined as an area that has municipal water and sewage services. Old Urban is any area that has been developed as an urban area for more than 40 years. Rural is all other areas. These major land use categories are further broken into three subcategories; Parkland (which includes greenbelts and woodlands), Residential, and Industrial (which includes heavy industry, commercial properties such as malls, and transportation rights-of-way). Rural also includes an Agricultural category.

The OTR guidelines apply only to samples collected using standard MOEE sampling, sample preparation, and analytical protocols. Because the background data were collected in Ontario, the OTRs represent Ontario environmental conditions.

The OTRs are not the only means by which results are interpreted. Data interpretation should involve reviewing results from control samples, examining all the survey data for evidence of a pattern of contamination relative to the suspected source, and where available, comparison with effects-based guidelines. The OTRs are particularly useful where there is uncertainty regarding local background concentrations and/or insufficient samples were collected to determine a contamination gradient. OTRs are also used to determine where in the anticipated range a result falls. This can identify a potential concern even when a result falls within the guideline. For example, if all of the results from a survey are close to the OTR_{98} this could indicate that the local environment has been contaminated above the *anticipated average,* and therefore the pollution source should be more closely monitored.

The OTRs identify a range of chemical parameters resulting from natural variation and normal human activity. ***As a result, it must be stressed that values falling within a specific*** OTR_{98} ***should not be considered as acceptable or desirable levels; nor does the*** OTR_{98} ***imply toxicity to plants, animals or humans.*** Rather, the OTR_{98} is a level which, if exceeded, prompts further investigation on a case by case basis to determine the significance, if any, of the above normal concentration. Incidental, isolated or spurious exceedences of an OTR_{98} do not necessarily indicate a need for regulatory or abatement activity. However, repeated and/or extensive exceedences of an OTR_{98} that appears to be related to a potential pollution source does indicate the need for a thorough evaluation of the regulatory or abatement program.

The OTR_{98} supersedes the Phytotoxicology ULN guideline. The OTR program is on-going. The number of OTRs will be continuously updated as sampling is completed for the various land use categories and sample types.